performing exposure of a pattern of a reticle onto a wafer by projecting EUV through a projection optical system that includes a diaphragm arranged in a vacuum;

cooling the diaphragm arranged in the vacuum through a cooling device having a heat removal path joined to the diaphragm;

detecting temperature information of the diaphragm with a sensor provided at a location not being irradiated with the EUV; and

manufacturing a device from the wafer.--

REMARKS

Applicants request favorable reconsideration and allowance of the subject application in view of the preceding amendments and the following remarks.

Claims 25 through 52 are now presented for examination. Claims 25, 32, 37 and 44 have been amended to define still more clearly what Applicants regard as their invention, in terms which distinguish over the art of record. Claims 49-52 have been added to assure Applicants of the full measure of protection to which they deem themselves entitled. Claims 25, 37 and 49-52 are the only independent claims.

Claims 25-48 have been rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor at the time the application was filed had possession of the claimed invention in that the specification disclosure at lines 13 through 20 of page 12 of "Although in the example of this embodiment, the present

invention is applied to an exposure optical system used in the atmosphere, the present invention is also applicable to an exposure apparatus using EUV or X-rays. In that case, the present invention is more effective, because exposure is performed in a vacuum, and a natural radiation effect is reduced more, as compared with a case in which the exposure is performed in the atmosphere." does not adequately support the claimed provision of "projection optical system including a diaphragm arranged in a vacuum".

Claims 25-48 have been rejected under 35 U.S.C. § 112, second paragraph, as indefinite in that the provision in Claims 25 and 37 of "projection optical system including a diaphragm arranged in a vacuum" vague and indefinite. With regard to the claims as amended, the rejections under 35 U.S.C. § 112, first and second paragraphs, are respectfully traversed.

Claim 25 as amended recites that exposure is performed using X-rays in a vacuum wherein a projection optical system includes a diaphragm arranged in the vacuum and Claim 37 as amended recites that exposure of a pattern of a reticle onto a wafer is performed through a projection optical system that includes a diaphragm arranged in a vacuum. It is clearly disclosed in the specification at lines 13 through 20 of page 12 that the invention is applicable to an exposure apparatus using EUV or X-rays and that the invention is more effective because the exposure is performed in a vacuum. The features of the use of X-rays in a vacuum and a diaphragm arranged in the vacuum are clearly supported by this disclosure since there is no change in structure of or method of using the projection optical system with its diaphragm arranged in a vacuum whether X-rays or

another radiation source is used or whether the arranging of a diaphragm is done in atmosphere or vacuum. Further, the second and third embodiments disclosed with respect to Figs. 3 through 5 do not refer in any manner to a system operating in atmosphere and do not exclude a system operating in a vacuum as disclosed in page 12.

The structure of the first embodiment is exactly the same whether used in atmosphere or vacuum. The second and third embodiments do not in any manner refer to a system operating in atmosphere and the structure and operation of the second and third embodiments are exactly the same whether vacuum or atmosphere is used. It is therefore believed that the features of Claims 25 and 37 of using X-rays and of a diaphragm in a vacuum are fully supported by the disclosure and the drawings and that Claims 25-48 as amended fully meet the requirements of 35 U.S.C. § 112, first and second paragraphs.

Claims 25-48 have been rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent 5,530,518 (Ushida et al.) in view of U.S. Patent 6,020,950 (Shiraishi) and further in view of U.S. Patent 5,142,148 (Sato). Claims 34, 35, 46 and 47 have been rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent Ushida et al. in view of Shiraishi and further in view of U.S. Patent 5,142,148 Sato and further in view of U.S. Patent 5,894,341 (Nishi et al.).

Independent Claim 25 as amended is directed to exposure apparatus that performs exposure using X-rays. In the apparatus, a projection optical system projects a pattern of a first object onto a second object using the X-rays. The projection optical

system includes a diaphragm arranged in the vacuum and a cooling device which cools the diaphragm.

Independent Claim 37 as amended is directed to a device manufacturing method in which exposure of a pattern of a reticle onto a wafer is performed by projecting X-rays through a projection optical system that has a diaphragm arranged in a vacuum. The diaphragm arranged in the vacuum is cooled and a device is manufactured from the wafer.

In Applicants' view, Ushida et al. discloses a projection exposure apparatus that includes an illuminating optical device for illuminating a projection negative and a projection optical device that projection-exposes a projection negative illuminated by the illumination optical device onto a substrate.

In Applicants' opinion, Shiraishi '950 discloses an exposure method and projection exposure apparatus in which a light shielding plate has a set of fixed peripheral openings with a fluid path through the center of the plate.

Sato, in Applicants' view, discloses a field emission scanning electron microscope in which an aperture plate is disposed in a high-vacuum region between an accelerating electrode and a condenser lens. The probe current is controlled by controlling an extracting voltage applied to an extracting electrode. Deviation of the focal point taking place in accompanying a change of a virtual electron source position as brought about by the control of the probe current is corrected by controlling the focal length of a condenser

lens such that the electron beam has a constant spread on the principal plane of an objective lens to thereby maintain a beam aperture angle α_i at a specimen to be constant.

According to the invention defined in Claims 25 and 37 as amended, the pattern of one object (reticle) is projected onto another object (wafer) through a projection optical system that has a diaphragm arranged in a vacuum. Ushida et al. may teach a projection optical system that projects a pattern on a reticle onto a photosensitive substrate with a diaphragm. As disclosed at lines 65-67 of column 3 and lines 24-26 of column 7, Ushida et al. only discloses the use of ultraviolet rays as exposure light and fails in any way to suggest the use of X-rays. As a result, the Ushida et al. disclosure is devoid of any teaching or any suggestion of using X-rays as exposure radiation.

Shiraishi discloses a cooling member having cooling fluid circulation. As disclosed at lines 42-44 of column 2 and lines 53-55 of column 14 in Shiraishi, the Shiraishi arrangement is restricted to using only ultraviolet light in his exposure arrangement but is devoid of any suggestion of projecting X-rays through a projection optical system that has a diaphragm in a vacuum as in Claims 25 and 34. It is not seen that the addition of Shiraishi's ultraviolet light exposure arrangement without a diaphragm being in arranged in a vacuum to Ushida et al.'s ultraviolet ray exposure light with a diaphragm not in a vacuum could possibly suggest the features of Claims 25 and 37.

Sato may teach an electron beam in a field emission scanning electron microscope (lines 41-48 of column 3) but fails to suggest the use of X-rays. As disclosed at lines 3-10 of column 2 in Sato, a vacuum environment is used and the degree of level of

vacuum is increased to make contamination less likely through illumination with the electron beam. In contrast to Sato's contamination reduction with respect to an electron beam, a vacuum is used in the present invention with respect to X-rays for a completely different reason to reduce a natural radiation effect.

None of Ushida et al., Shiraishi and Sato in any manner teach or suggest the use of X-rays through a projection optical system as in Claims 25 and 37. Further, Sato's use of a vacuum for an electron beam to reduce contamination is directed away from and fails in any manner to suggest use of a vacuum to reduce a natural radiation effect as in Claims 25 and 37. As a result, it is not seen that the addition of Sato's vacuum to reduce contamination in an electron beam plate aperture to Shiraishi's ultraviolet ray arrangement out of a vacuum and Ushida et al.'s ultraviolet ray exposure light could possibly suggest the features of Claims 25 and 37. It is therefore believed that Claims 25 and 37 as amended are completely distinguished from any combination of Ushida et al., Shiraishi and Sato and are allowable.

Newly added independent Claim 49 is directed to exposure apparatus that performs exposure using EUV in a vacuum in which a projection optical system projects a pattern of a first object onto a second object using the EUV. The projection optical system includes a diaphragm arranged in a vacuum and a cooling device which cools the diaphragm through a heat removal path joined to the diaphragm.

Newly added independent Claim 50 is directed to a device manufacturing method in which exposure of a pattern of a reticle onto a wafer is performed by projecting

EUV through a projection optical system that includes a diaphragm arranged in a vacuum. A diaphragm arranged in the vacuum is cooled through a cooling device having a heat removal path joined to the diaphragm. A device is manufactured from the wafer.

It is a feature of Claims 49 and 50 that a projection optical system has a diaphragm cooled through a heat removal path joined to the diaphragm in a vacuum. As discussed with respect to Claims 25 and 37, neither Ushida et al. nor Shiraishi in any manner teaches or suggests that a diaphragm joined to a heat removal path is arranged in a vacuum. Sato may teach a field emission scanning electron microscope with an aperture plate that determines the diameter of an electron beam. The aperture plate is placed in a high vacuum solely to make contamination through illumination with the electron beam less likely. Sato's electron beam in a scanning electron microscope, however, is unrelated to a projection optical system using EUV, has a vacuum for a completely different purpose than in Claims 49 and 50 and is devoid of any suggestion of a cooling device with a heat removal path joined to a diaphragm arranged in a vacuum as in Claims 49 and 50. It is therefore not seen that the addition of Sato's use of a vacuum for electron beam aperture plate in a scanning electron microscope added to Shiraishi and Ushida et al. devoid of a diaphragm arranged in a vacuum could possibly suggest the features of Claims 49 and 50. It is therefore believed that newly added Claims 49 and 50 are completely distinguished from any combination of Ushida et al., Shiraishi and Sato and are allowable.

Newly added independent Claim 51 is directed to exposure apparatus that performs exposure using EUV in a vacuum. In the apparatus, a projection optical system

projects a pattern of a first object onto a second object using the EUV. The projection optical system has a diaphragm arranged in the vacuum and a cooling device which cools the diaphragm. A sensor detects temperature information of the diaphragm. The sensor is located at a position not being irradiated with the EUV.

Newly added independent Claim 52 is directed to a device manufacturing method in which exposure of a pattern of a reticle onto a wafer is performed by projecting EUV through a projection optical system that includes a diaphragm arranged in the vacuum. The diaphragm arranged in the vacuum is cooled through a cooling device having a heat removal path joined to the diaphragm. Diaphragm temperature information is detected with a sensor provided at a location not being irradiated with the EUV. A device is manufactured from the wafer.

It is a feature of Claims 51 and 52 that temperature information of a diaphragm arranged in a vacuum in a projection optical system using EUV is provided at a location not being irradiated with the EUV. In contrast, both Ushida et al. and Sato are devoid of any teaching or suggestion of detecting temperature information or of a temperature sensor. Shiraishi may disclose a temperature control CL that supplies a temperature-controlled fluid to a light shielding member for cooling that is remote from the diaphragm in a projection optical system but is devoid of any suggestion of a temperature information sensor at a location not irradiated with EUV. Since none of the cited references teaches or suggests the feature of Claims 51 and 52 of detecting temperature information of a diaphragm of a projection optical system arranged in a vacuum with a sensor provided at a

location not being irradiated with EUV, it is believed that newly added Claims 51 and 52 are completely distinguished from any combination of Ushida et al., Shiraishi and Sato and are allowable.

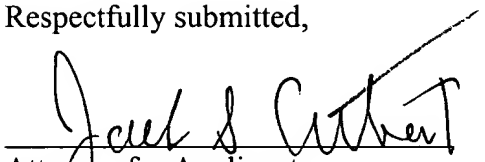
For the foregoing reasons, Applicants submit that the present invention, as recited in independent claims 25, 37 and 49-52 is patentably defined over the cited art, whether that art is taken individually or in combination.

The dependent claims also should be deemed allowable, in their own right, for defining other patentable features of the present invention in addition to those recited in their respective independent claims. Further individual consideration of these dependent claims is requested.

Applicants further submit that the instant application is in condition for allowance. Favorable reconsideration, withdrawal of the objection and rejections set forth in the above-noted Office Action and an early Notice of Allowance are requested.

Applicants' attorney, Steven E. Warner, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should be directed to our address listed below.

Respectfully submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

25. (Amended) An exposure apparatus for performing exposure using X-rays in a vacuum comprising:

a projection optical system which projects a pattern of a first object onto a second object by using [EUV] the X-rays, said projection optical system including a diaphragm arranged in [a] the vacuum, and a cooling device which cools said diaphragm.

32. (Amended) An apparatus according to Claim 31, wherein said sensor is located at a position not being irradiated with the [EUV] X-rays.

37. (Amended) A device manufacturing method comprising the steps of:

performing exposure of a pattern of a reticle onto a wafer by projecting X-rays[,] through a projection optical system [having] that includes a diaphragm [and a cooling device, a pattern of a reticle onto a wafer by using EUV] arranged in a vacuum;

cooling[, by using the cooling device,] the diaphragm arranged in [a] the vacuum; and

manufacturing a device from the wafer.

44. (Amended) A method according to Claim 43, further comprising providing the sensor at a location not being irradiated with the [exposure beam] X-rays.